Position Paper: Benchmark Criteria for Function Modeling

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We are a team of researchers in the Design Intelligence Laboratory of the Georgia Institute of Technology where we have been working on functional modeling for over twenty years. We have developed the Structure-Behavior-Function (SBF) language, which has been used for modeling technical systems, such as mechanical devices (Goel, Rugaber & Vattam 2009). Over the past few years, we have also used SBF for modeling biological systems and explored how constructing functional models can help students obtain a deeper understanding of such systems. Currently, we are extending our approach and language to deal with the complexities of biologically inspired design, ecological forecasting and cancer pathways. For the purposes of this workshop, we ask what are the essential aspects of *function* and functional modeling upon which benchmarks should be founded? Here are several that come to mind:

Foundations: The term *function* has many definitions and uses. Before we can measure and compare functional modeling approaches, we should understand those roots, such as the following.

- **Cognitive**: What cognitive roles does function play? To what extent does the functional modeling approach conform to our current understanding of the cognitive roles of function?
- **Linguistic**: What role do verbs play in the structure and exercise of natural languages? To what extent does the functional modeling approach conform to the role of *function* in natural language?
- **Computational**: To what extent has the functional modeling approach been automated, e.g. language definition; parser; validator; semantics; simulator; generator? How has the usability and usefulness of the automated tools been measured? How effective have they been?
- **Formal**: What is the relation between functional modeling and the mathematical concept of *function*? To what extent has the functional modeling notation been formally defined?

Controlled Vocabulary: Various ontologies of functions have been proposed. To what extent does the functional modeling approach make use of them? What is the conceptual basis of that vocabulary?
Domains: Functional modeling has been applied to a variety of domains. What is the relationship of the domain to functional modeling approach taken? For that matter, what are the essential differences between the approaches taken? For any given approach to functional modeling, how generally has it been applied, and what is given up in precision or power for any increment in generality?
Applications: Functional modeling has been used for a variety of purposes including diagnosis, repair, documentation, training, design, reverse engineering and explanation. How has its effectiveness been evaluated for each of these tasks? What is the tradeoff between task specificity and power?
Reasoning: What interesting inferences can be drawn from a functional model? To what extent do the models support simulation?
Scale: What sizes of system have been modeled? How complex are they? How does the modeling approach deal with such complexity? In particular, what abstraction mechanisms does it provide?
Notation: From a strictly notational point of view, a functional modeling approach can be thought of as a language. As such, it can be evaluated on its notational characteristics such as p*recision, power, expressiveness, implementability,* and *formality*.
Method: Functional modeling is itself a function. To what extent does a given functional modeling approach satisfy its own goals? Also, to what extent does the approach have a well-defined, repeatable process? How does the process prescribe evaluating resultant models? To what extent are such evaluations predictive of the effectiveness of the modeling approach to the accomplishment of the approach's ultimate function?
Adoption and Impact: Ultimately, the exploration of functional modeling itself has a function: to better understand the role that functional modeling can have in generating end user benefit. To what extent has this benefit been measured? As a surrogate, how as interest been assessed (downloads, citations, etc.)?

Reference: A. Goel, S. Rugaber, and S. Vattam. Structure, Behavior and Function Models of Complex Systems: The Structure-Behavior-Function Modeling Language. AIEDAM 23:23-35, 2009.